

CONTRIBUTIONS
FROM THE
CUSHMAN LABORATORY
FOR
FORAMINIFERAL RESEARCH

VOLUME 16, PART 1

MARCH, 1940

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SHARON, MASSACHUSETTS, U. S. A.

1940

CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

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Subscription \$2.50 per year post paid.

Volume 1, April 1925—January 1926 (Reprinted, 1935)	\$3.00
Volume 2, April 1926—January 1927 (Reprinted, 1935)	\$3.00
(Volume 3, part 1 now out of print.)	
Volume 3, parts 2-4, June—December, 1927 (Reprinted, 1936)	\$2.00
Volume 4, parts 1-4, March—December, 1928, complete	\$2.50
Volume 5, parts 1-4, March—December, 1929, complete	\$2.50
Index to Volumes 1—5 inclusive	\$1.00
Volume 6, parts 1-4, March—December, 1930, complete	\$2.50
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Volume 8, parts 1-4, March—December, 1932, complete	\$2.50
Volume 9, parts 1-4, March—December, 1933, complete	\$2.50
Volume 10, parts 1-4, March—December, 1934, complete	\$2.50
Index to Volumes 6—10 inclusive	\$1.00
Volume 11, parts 1-4, March—December, 1935, complete	\$2.50
Volume 12, parts 1-4, March—December, 1936, complete	\$2.50
Volume 13, parts 1-4, March—December, 1937, complete	\$2.50
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Copies of Volume 16, part 1 were first mailed March 19, 1940

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CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

214. THE GENUS *STENSIOINA* AND ITS SPECIES

By J. A. CUSHMAN and A. L. DORSEY

In 1936 Brotzen erected the new genus *Stensioina* with its genotype *Rotalia exsculpta* Reuss. We have made a study of the type species from topotype specimens and also of other species as represented in our collections. The genus seems to belong to the Rotaliidae and is rather restricted in the Upper Cretaceous of Europe and America so far as known, and the species should make excellent index fossils. The various species have been included in different genera in the literature as will be noted under the synonymy given here.

Genus *STENSIOINA* Brotzen, 1936

Genotype, *Rotalia exsculpta* Reuss

Stensioina BROTZEN, Sver. Geol. Under., ser. C., No. 396, 1936, p. 164.

Rotalia (part); *Truncatulina* (part); *Cibicides* (part); *Gyroidina* (part) of authors.

Test trochoid, usually plano-convex, dorsal side flattened or slightly convex, ventral side convex, usually umbilicate, all chambers visible from the ventral side; chambers simple, depressed or slightly raised in some species; wall calcareous, perforate, often coarsely so on the ventral side; aperture an elongate slit at the base of the last-formed chamber on the ventral side.

The genus includes ornate species from the Upper Cretaceous. the raised ornamentation of the dorsal side being especially marked. While in some respects the species resemble some of those assigned to *Anomalina* or *Cibicides*, the apertural characters

are more like those of *Gyroidina* and would seem to place the genus in the Rotaliidae.

The following species occur in the material at our disposal:

STENSIOINA EXSCULPTA (Reuss) (Pl. 1, figs. 1-3)

Rotalia exsculpta REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 222, pl. 11, figs. 4 a-c.

Stensioina exsculpta BROTZEN, Sver. Geol. Under., ser. C., No. 396, 1936, p. 165, pl. 11, figs. 8 a-c.

Test of medium size, trochoid, biconvex, dorsal side slightly convex, ventral side strongly convex, peripheral margin acute, ventrally slightly umbilicate; chambers distinct, uniform in shape but increasing gradually in size as added, usually 11 in last-formed whorl; sutures on the dorsal side distinct, raised, the spiral suture very distinct, conforming with the outer curve of the chambers, forming a smooth, lobulate keel at the periphery, the suture lines marked by irregular, nearly straight costae which are roughly tangential to the spiral suture, on the ventral side the sutures slightly raised and curved, occasionally somewhat sigmoid; wall distinctly perforate, ventral side fairly smooth, areas between the sutures papillate and typically without supplementary ornamentation; aperture an elongate, low, arched, slightly lipped opening at the base of the last-formed chamber on the ventral side, closer to the periphery than to the umbilical area. Diameter 0.25-0.50 mm.; thickness 0.15 mm.

We have specimens in our Cretaceous collections from the following localities: Diluvial sande, Hamm, Westphalia, Germany (topotypes); Emscher mergel, Gosler Petersberg, Hannover, Germany; Unter Senon, Brambauer near Dartmund, Westphalia, Germany; Ober Senon, Peine, Hannover, Germany; Ober Senon, Quadraten Kreide, between Heesen and Ahlen, Westphalia, Germany.

Additional European localities, from which we have seen no material, are given in the above references.

STENSIOINA POMMERANA Brotzen (Pl. 1, fig. 4)

Stensioina pommerana BROTZEN, Sver. Geol. Under., ser. C., No. 396, 1936, p. 166.

Discorbina exsculpta MARRSON (not REUSS), Mitth. nat. Ver. Neu. Vorpommern und Rügen, Jahrb. 10, 1878, p. 164.

Rosalina clementina (part) BEISSEL (not D'ORBIGNY), Abhandl. kön. Preuss. geol. Landes., n. ser., vol. 3, 1891, p. 75, pl. 16, figs. 10, 12, 13 (not 6-9, 11, 14-16).

Rotalia exsculpta FRANKE (not REUSS), Abhandl. geol.-pal. Instit., Univ. Greifswald, vol. 6, 1925, p. 90, pl. 8, figs. 6 *a-c*; Abhandl. Preuss. Geol. Landes., n. ser., vol. 111, 1928, p. 189, pl. 18, figs. 3 *a-c*.

Test small, trochoid, plano-convex, dorsal side flattened, ventral side decidedly convex, peripheral margin acute, ventrally slightly umbilicate; chambers distinct, uniform in shape but increasing gradually in size as added, 11 to 12 in the last-formed whorl; sutures on the dorsal side distinct, raised, the spiral suture a continuous, irregular costa forming a keel at the periphery, the suture lines irregular, nearly tangential to the spiral suture in the early chambers, but curved in the later ones, on the ventral side very slightly depressed, distinct, marked by a band of clear shell material, broadly curved toward periphery; wall coarsely perforate, ventral side smooth, dorsally, areas between sutures roughened, occasionally bearing irregular nodes and costae; aperture an elongate, low, arched slit at the base of the last-formed chamber on the ventral side, closer to the umbilical area than to the periphery. Diameter 0.30-0.40 mm.; thickness 0.20 mm.

This species may be distinguished from *S. exsculpta* by its smaller size, flat dorsal side and beginning of ornamentation in the areas between the sutures on the dorsal side.

We have specimens in our Cretaceous collections from the following localities: Ober Senon, from the Island of Rügen, Germany (topotypes) and from Friedrichsberg by Aachen, Germany. Very similar specimens occur in the chalk of Gravesend, England.

STENSIOINA LABYRINTHICA Cushman and Dorsey, n. sp. (Pl. 1, fig. 5)

? *Gyroidina exsculpta* MACFADYEN (not REUSS), Geol. Mag., vol. 69, 1932, pl. 35, figs. 26 *a-c*.

Test small, trochoid, plano-convex, dorsal side flattened, ventral side strongly convex, peripheral margin acute, ventrally slightly umbonate; chambers distinct, uniform in shape but increasing gradually in size as added, about 10 in the last-formed whorl; sutures on the dorsal side distinct, raised, the spiral suture distinct, forming an irregular keel at the periphery, twisting costae marking the suture lines, on the ventral side distinct, composed of clear shell material, slightly limbate, gently curved; wall finely perforate, smooth on the ventral side, dorsally bearing nodes, supplementary costae and numerous irregular extensions of the

sutural costae giving the effect of a labyrinth; aperture an elongate, low, arched slit at the base of the last-formed chamber on the ventral side, midway between the umbilical area and the periphery. Diameter 0.35-0.50 mm.; thickness 0.20 mm.

Holotype (Cushman Coll. No. 35112) from the Cretaceous, Mukronaten-Kreide, Lemberg, Galicia.

This species differs from *S. pommerana* in its labyrinthic dorsal ornamentation due to a greater development of ornamentation between the suture lines, umbonate ventral side and limbate sutures on the ventral side.

Besides the type specimens from the Mukronaten-Kreide, Lemberg, Galicia, we have specimens from the chalk of Antrim, Ireland.

STENSIOINA EXCOLATA (Cushman) (Pl. 1, fig. 6)

Truncatulina excolata CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, 1926, p. 22, pl. 3, figs. 2 a, b.

Gyroidina excolata WHITE, Journ. Pal., vol. 2, 1928, p. 293, pl. 40, fig. 2.

Test of medium size, trochoid, plano-convex, dorsal side flattened and almost completely involute, ventral side strongly convex, approaching a hemisphere in side view, peripheral margin acute, keeled, umbilical area smooth; chambers indistinct, uniform in shape, but increasing rapidly in size as added, usually 9 in the last-formed whorl; sutures on the dorsal side distinct, raised, spiral suture very indistinct, showing only in the earliest portion, suture lines marked by irregular, variously twisted, gently curved costae, on the ventral side sutures quite indistinct, slightly depressed, gently curved; wall perforate, smooth on the ventral side, intermediate areas on the dorsal side roughened; aperture an elongate, low, arched opening at the base of the last-formed chamber on the ventral side, closer to the umbilical area than to the periphery. Diameter 0.50 mm.; thickness 0.25 mm.

This species differs from *S. exsculpta* in its flattened dorsal surface, indistinct spiral suture and its greater thickness in relation to the diameter.

Both *S. excolata* and the other American species, *S. americana*, are more distinctly involute on the dorsal side than are the European species.

This species occurs in the Mendez shale in a railroad cut near Coco (type locality), and also near Las Palmas, both in Hacienda El Limon, San Luis Potcsi, Mexico. White also records it from this general region.

STENSIOINA AMERICANA Cushman and Dorsey, n. sp. (Pl. 1. fig. 7)

Cibicides excolata CUSHMAN (not *Truncatulina excolata* CUSHMAN, 1926), Journ. Pal., vol. 5, 1931, p. 315, pl. 36, figs. 8 a-c; l. c., vol. 6, 1932, p. 345.

Stensioina excolata COLE (not CUSHMAN), Florida Geol. Survey, Bull. 16, 1938, p. 35 (list), pl. 3, figs. 2, 3.

Test small, trochoid, dorsal side flattened with central portion slightly concave, ventral side broadly convex with ventral periphery forming an angle less than 90 degrees with the dorsal side, thickness less than one-half the diameter, peripheral margin acutely keeled, ventrally umbonate, but the umbilical area flat to depressed; chambers distinct, uniform in shape, increasing regularly in size as added, usually 8 in the last-formed whorl; sutures on the dorsal side distinct, raised, spiral suture indistinct, irregular and broken, suture lines marked by irregular, broken, gently curved costae, on the ventral side the sutures slightly depressed, gently curved, marked by narrow bands of clear shell material; wall coarsely perforate, ventrally smooth, dorsally with intermediate areas roughened and occasionally bearing irregular costae or nodes; aperture an elongate, low, arched slit, midway between the umbilical area and the periphery. Diameter 0.30-0.40 mm.; thickness 0.15 mm.

Holotype (Cushman Coll. No. 35124) from the Cretaceous, upper Taylor, branch of Kickapoo Creek, 1,200 ft. S. of public rd., 1.8 mi. N.W. of Annona, Red River Co., Tex.

This species may be distinguished from *S. excolata* by its smaller size, more evident spiral suture and concave dorsal side. It differs from the European species, *S. pommerana*, in its fewer chambers, coarser perforations, concave dorsal side and less distinct spiral suture.

In addition to the type locality we have specimens from the following localities: Upper Taylor, Milton rd., W-facing slope of branch valley, 1 mi. W. of Deport, Lamar Co., Tex.; Mulberry Creek, 1,100 ft. S. of rd. crossing, $\frac{1}{2}$ mi. S. of Milton, Lamar Co., Tex.; ditch 3.9 mi. E. of Farmersville on Greenville rd., Collin Co., Tex.; N. side of U. S. hwy. 80, 6.5 mi. E. of Dallas-Kaufman Co. line, Kaufman Co., Tex.; on rd. to State Rock Ferry, 1.9 mi. E. of Bristol, Ellis Co., Tex.; Rugby rd., 1.9 mi. E. of Deport, Red River Co., Tex.; Paris hwy., 1.8 mi. E. of Deport, Red River Co., Tex.; branch of Scatter Creek, 3.5 mi. S.W. of Clarksville, Red River Co., Tex. Pecan Gap chalk, Greenville rd., 5.1 mi. S. by W. of Wolfe City, Tex. Saratoga chalk, $3\frac{1}{4}$ mi. N.W. of Washington,

Hempstead Co., Ark. Neylandville marl, Barton's Bluff, Tombigbee River, Marengo Co., Ala. Prairie Bluff chalk, U. S. hwy. 80, 2.4 mi. E.S.E. of Southern Railway underpass at Livingston, Sumter Co., Ala. Lower Navarro, Dallas rd., 4.3 mi. S.W. of Greenville, Hunt Co., Tex.; 10 mi. W. by S. of Dekalb, Bowie Co., Tex.

Cole records this species from the Selma chalk of a deep well in Florida.

The earliest occurrence of *Stensioina* is in the Upper Cretaceous of central Europe represented by the type species, *S. exsculpta* (Reuss). This species is definitely biconvex and shows the relationship of the genus to its probable ancestor, *Eponides* or *Gyroidina*, and seems to definitely belong in the family Rotaliidae. The ornamentation in the type species consists of raised sutures which, in the early portion, are tangential to the spiral suture but later become curved. Later in the Cretaceous occurs *S. pommerana* which is plano-convex and is ornamented with curved sutures almost throughout with occasional supplementary ornamentation in the intermediate areas. This in turn is followed by *S. labyrinthica* in which the ornamentation of the intermediate areas on the dorsal side becomes marked. Sometime in the late Cretaceous the genus must have migrated to America where it is represented by two species, *S. exsculpta* in Mexico and *S. americana* in the upper Taylor and lower Navarro of the Coastal Plain region of the United States. Both of the American species are much more involute on the dorsal side than the European ones and in *S. americana* the dorsal side becomes distinctly concave. So far as is known the genus became extinct in the later Cretaceous both in Europe and America. It will be interesting to discover if this genus is not also represented in the Cretaceous in other parts of the world.

EXPLANATION OF PLATE 1

FIGS. 1-3. *Stensioina exsculpta* (Reuss). 1. (After Reuss' type figure.) a, dorsal view; b, ventral view; c, peripheral view. 2, 3. $\times 80$. 2, Dorsal view of old age specimen; 3 a, dorsal view; b, ventral view; c, peripheral view. 4 a-c. *Stensioina pommerana* Brotzen. $\times 80$. a, dorsal view; b, ventral view; c, peripheral view. 5 a-c. *Stensioina labyrinthica* Cushman and Dorsey, n. sp. $\times 55$. a, dorsal view; b, ventral view; c, peripheral view. 6 a-c. *Stensioina excolata* (Cushman). $\times 60$. a, dorsal view; b, ventral view; c, peripheral view. 7 a-c. *Stensioina americana* Cushman and Dorsey, n. sp. $\times 80$. a, dorsal view; b, ventral view; c, peripheral view. Drawings by Ann Shepard.



1a



1c



1b



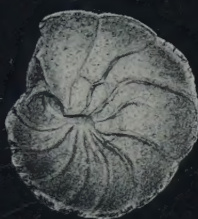
2



3a



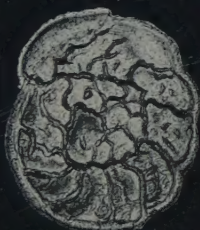
3c



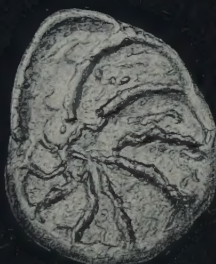
3b



4a



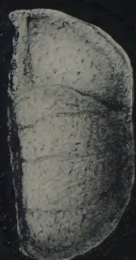
5a



6a



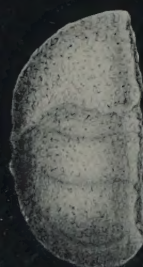
7a



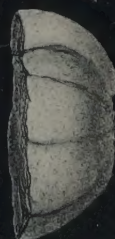
4c



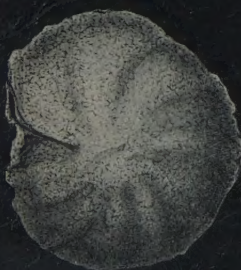
5c



6c



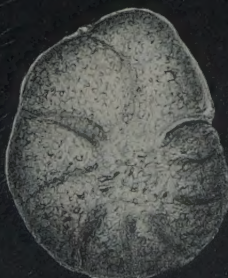
7c



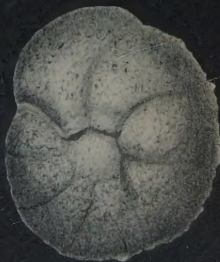
4b



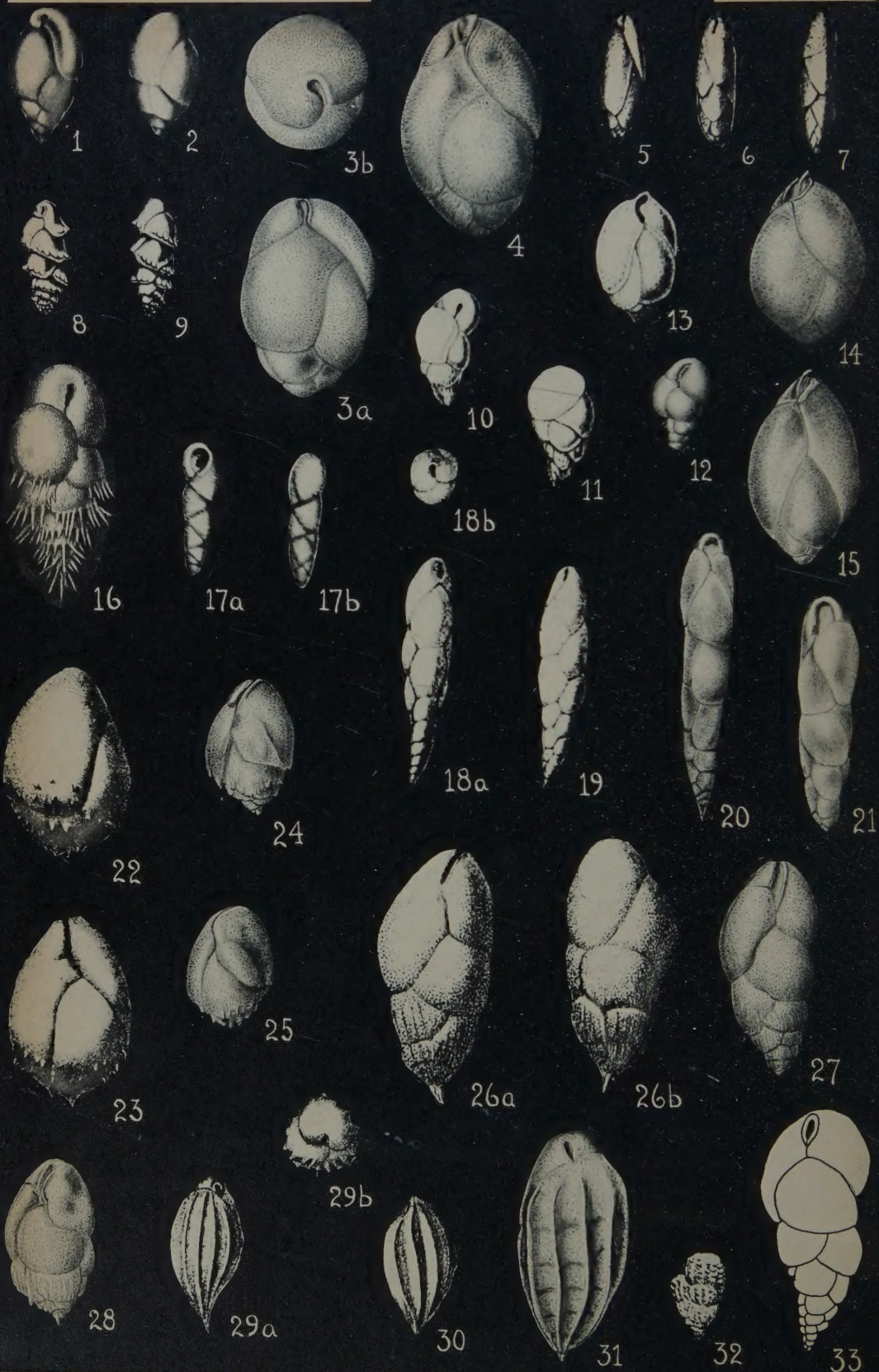
5b



6b



7b



215. THE SPECIES OF THE GENUS *BULIMINA* HAVING RECENT TYPES

By J. A. CUSHMAN and F. L. PARKER

In a previous paper (Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 90) the species of *Bulimina* named by d'Orbigny in 1826 were discussed. The remaining species named from the Recent have now been studied. Topotype material has been used wherever possible.

In all cases where no material was available the original figures and descriptions are given for reference.

A study of some of the smooth forms of the genus shows that certain species develop a terminal aperture in the adult forms for which the subgeneric name *Desinobulimina* is proposed.

BULIMINA AFFINIS d'Orbigny (Pl. 2, figs. 1-4)

Bulimina affinis D'ORBIGNY, in De la Sagra, Hist. Phys. Pol. Nat. Cuba, 1839, "Foraminifères," p. 105, pl. 2, figs. 25, 26.

Test large, composed of three to four whorls, broadly ovate; chambers distinct, those of the last whorl composing three-fifths or more of the test, inflated; sutures distinct, depressed, especially

EXPLANATION OF PLATE 2

FIGS. 1-4. *Bulimina affinis* d'Orbigny. 1, 2, (after d'Orbigny), Cuba; 3, 4, $\times 38$, *Atlantis* sta. 1573, 3 a, side view, 3 b, apertural view. 5-7. *B. squammigera* d'Orbigny. (After d'Orbigny), Teneriffe, Canary Islands. 8, 9. *B. pulchella* d'Orbigny. (After d'Orbigny), west coast of South America. 10-12. *B. patagonica* d'Orbigny. 10, 11, (after d'Orbigny), bay of San Blas, Patagonia. 12, $\times 70$, off Grovenador, Rio de Janeiro Harbor, Brazil. 13-15. *B. ovula* d'Orbigny. 13, (after d'Orbigny), west coast of South America. 14, $\times 38$, *Guide* sta. 15(24). 15, $\times 52$, 1½ miles south of Scripps Institution Pier, California. 16. "*Bulimina pupoides* d'Orbigny, var. *spinulosa* Williamson." (After Williamson), British Isles. 17. *B. oceanica* Terquem. $\times 40$, (after Terquem), Dunkerque, France. 18-21. *B. exilis* H. B. Brady. $\times 52$. 18, 19, (after H. B. Brady), *Porcupine* sta. 20, northwest of Ireland, 18 a, front view, 18 b, apertural view. 20, 21, *Porcupine* sta. 29. 22-25. *B. pyrula* d'Orbigny, var. *spinescens* H. B. Brady. $\times 52$. 22, 23, (after H. B. Brady), Ki Islands. 24, 25, *Albatross* sta. D5222. 26-28. *B. subornata* H. B. Brady. 26, $\times 65$, (after H. B. Brady), south of Japan. 27, $\times 52$, *Albatross* sta. D5119. 28, $\times 52$, *Albatross* sta. D5214. 29-31. *B. rostrata* H. B. Brady. 29, 30, $\times 65$, (after H. B. Brady), Ki Islands. 31, $\times 90$, *Lydonia* sta. 30. 32. *B. ornata* Egger. (After Egger), *Gazelle* sta. 90, off west Australia. 33. *B. consobrina* Fornasini. $\times 38$. (After Fornasini), Porto Corsini, near Ravenna, Italy.

that of the last chamber; wall transparent, coarsely perforate; aperture loop-shaped, with a slight lip and a plate-like tooth. Length (of figured specimens): 0.82-0.92 mm.; diameter 0.55-0.60 mm.

d'Orbigny described this species as being 0.50 mm. in length. As he had only one specimen it is possible that it was an immature one. His original figures are reproduced here. Our figured specimens are from *Atlantis* sta. 1573, south of Cape Cruz, Cuba, in 555 fathoms. They seem to agree well with d'Orbigny's description, although the initial end of the test is not pointed as shown in his figure. The shape and arrangement of the chambers is very similar. He describes the species as close to "*Bulimina laevigata*" d'Orbigny, differing from it in the slight depression of the last chamber, and by the whorls which are less widely separated. A comparison of our specimens with specimens from Rimini and with specimens of *B. ovata* d'Orbigny (of which *B. laevigata* is a synonym—Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 94) from the Miocene of the Vienna Basin shows these same differences. In addition, *B. affinis* is a considerably larger form and is broader in proportion to its length.

BULIMINA SQUAMMIGERA d'Orbigny (Pl. 2, figs. 5-7)

Bulimina squammigera D'ORBIGNY, in Barker-Webb and Berthelot, Hist. Nat. Isles Canaries, vol. 2, pt. 2, "Foraminifères," 1839, p. 137, pl. 1, figs. 22-24.

Test elongate, almost cylindrical, smooth and polished, although marked with small, evenly spaced points, very obtuse at the ends. Spire elongate, turret-like, composed of five slightly swollen whorls, without a deep suture. Chambers elongate, oblong, especially in the younger portion, becoming much more swollen in the adult portion; all somewhat pointed at the basal end, giving the appearance altogether of scales placed in regular rows; the last chamber entirely convex right up to the edge of the aperture. Aperture virguline, placed at the upper end of the last chamber. Color white. Total length 0.50 mm.

A translation of d'Orbigny's original description is given above and his figures are reproduced on our plate. The species was described from Teneriffe in the Canary Islands.

We have no specimens referable to this species but it seems

possible from the figures and description that it belongs in the genus *Buliminella*.

"BULIMINA PULCHELLA d'Orbigny"=BULIMINA MARGINATA d'Orbigny

(Pl. 2, figs. 8, 9)

Bulimina pulchella D'ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 50, pl. 1, figs. 6, 7.

Bulimina patagonica CUSHMAN and KELLETT (not D'ORBIGNY), Proc. U. S. Nat. Mus., vol. 75, art. 25, 1929, p. 7, pl. 3, figs. 4 a, b.—CUSHMAN and WICKENDEN, l. c., vol. 75, art. 9, 1929, p. 8, pl. 3, fig. 11.

Bulimina serrata BAILEY, Smithsonian Contrib., vol. 2, art. 3, 1851, p. 12, pl., figs. 32-34.

Test very elongate, subcylindrical, polished, pointed at base. Spiral portion elongate, "scalariform," turreted, composed of seven very convex whorls, keeled at the base, each chamber marked on its rounded surface by small, obtuse spines, flattened, appearing on the keel as even crenulations; sutures very depressed, "en rampe." Chambers broader than long, angled, oblique, the last inflated throughout. Aperture virguline and surrounded by a lip, placed at the top of the last chamber. Color white. Length one-third of a millimeter.

A translation of d'Orbigny's original description is given above and his figures are reproduced on our plate. The types of the species are from the coast of Peru and Chile. d'Orbigny describes the species as differing from *B. marginata* in its more elongate character. A study of suites of specimens from various localities, however, shows that elongate specimens are found occurring with shorter, broader forms, and there seems little doubt that the two types represent variations of the same species. It seems, therefore, that *B. pulchella* should be placed in the synonymy under *B. marginata*.

B. serrata Bailey is also placed here in the synonymy. His figures are very small and indefinite, but his description points definitely to this species which occurs in abundance along the east coast of the United States in the vicinity of his type localities.

BULIMINA PATAGONICA d'Orbigny (Pl. 2, figs. 10-12)

Bulimina patagonica D'ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 50, pl. 1, figs. 8, 9.—CUSHMAN and PARKER, Proc. U. S. Nat. Mus., vol. 80, art. 3, 1931, p. 14, pl. 3, fig. 14.

Test oblong, conical, very polished on the last whorls, rough, covered with small spines on the remainder, these projecting all the more as they are at the base, and completely conceal the spire,

composed of five rounded whorls, separated by somewhat depressed sutures. Chambers broader than high, three to a whorl, all somewhat inflated and distinct, the last inflated and larger than the rest. Aperture virguline, placed almost in the center of the width of the chamber. Color white. Length, 0.66 mm.

A translation of d'Orbigny's original description is given above and his figures are reproduced on our plate.

We have refigured the specimen from our paper on the East Coast of South America. It occurred off Grovenador, Rio de Janeiro Harbor, Brazil, in 3 fathoms. It is much smaller than the form described by d'Orbigny from the Bay of San-Blas, Patagonia, and probably represents an immature specimen. Its other characteristics seem to agree well with d'Orbigny's figures and description which also appear to represent a young form. He differentiates the species from *B. echinata* by its conical shape, and from *B. aculeata* by its more elongate whorls, less globular chambers and its much finer spines. The form is also close to *B. elongata* d'Orbigny, var. *subulata* Cushman and Parker from the Miocene of the Vienna Basin, but differs from it in the inflation of the last whorl. A further discussion of the relationships of this form with *B. elongata* is given under *B. patagonica*, var. *glabra* Cushman and Wickenden.

BULIMINA OVULA d'Orbigny (Pl. 2, figs. 13-15)

Bulimina ovula D'ORBIGNY, Voy. Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 51, pl. 1, figs. 10, 11.

Test oval, fragile, translucent, marked throughout with small, scarcely visible points, which are thicker on its rounded extremities. Spire very short, occupying scarcely one-fifth of the total length, composed of four or five indistinct whorls, without distinct sutures, pointed at the bottom. Chambers oval, longer than broad, slightly convex, involute for three-quarters of their length, the last convex, occupying four-fifths of the total length, two to a whorl. Aperture very long, bordered by a lip and extending the entire length of the apertural end of the last chamber, with a small, sharp point rising from it. Color white. Length 0.50 mm.

A translation of d'Orbigny's original description is given above and his figures are reproduced on our plate. The types of the species are from the coast of Chile and Peru. As we have no specimens from this locality specimens from *Guide* sta. 15(24), Lat. 43° 02' N., Long. 125° W., in 571 fathoms, and from a station

1½ miles south of Scripps Institution Pier, La Jolla, California, in shallow water, are figured.

The form is very close to *B. pyrula* d'Orbigny, but is larger, with more inflated chambers and lacks the occasional spines.

"BULIMINA PUPOIDES d'Orbigny, var. SPINULOSA Williamson"=
BULIMINA ACULEATA d'Orbigny (Pl. 2, fig. 16)

Bulimina pupoides D'ORBIGNY, var. *spinulosa* WILLIAMSON, Rec. British Foram., 1858, p. 62, pl. 5, fig. 128.

There can be little doubt from the description and figures given by Williamson that this form should be placed in the synonymy under *B. aculeata* d'Orbigny. Sherborn points out this fact in his Index to the Genera and Species of the Foraminifera (Smithsonian Misc. Coll., vol. 37, No. 856, 1893, p. 33). The original figure is reproduced here.

BULIMINA OCEANICA Terquem (Pl. 2, fig. 17)

Bulimina oceanica TERQUEM, Essai Class. Anim. Dunkerque, fasc. 3, 1881, p. 127, pl. 16, figs. 10 a, b.

Test elongate, narrow, conical, polished, obtuse at the ends, composed of four whorls, with triangular chambers, convex, the last rounded, aperture round, lateral, placed at the bottom of an acute, oval depression, with a lip.

A translation of Terquem's original description is given. We have no specimens referable to this species, although it is possible that it represents *B. elongata* d'Orbigny which occurs in this region. Terquem's form, however, seems to be much narrower in proportion to its length so that it seems best not to try to place them together. The figures, which are reproduced here, also suggest that the species may belong to the genus *Buliminella* as the spiral suture is very marked.

"BULIMINA ELEGANS d'Orbigny, var. EXILIS H. B. Brady"=

BULIMINA EXILIS H. B. Brady (Pl. 2, figs. 18-21)

Bulimina elegans D'ORBIGNY, var. *exilis* H. B. BRADY, Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 399, pl. 50, figs. 5, 6.

"Test much elongated, slender, tapering, more or less compressed on three sides, oral end subacute or rounded, aboral extremity acuminate. Segments numerous, oblique, somewhat inflated, arranged in a regular triserial spire. Length, ⅓⁵th inch (0.75 mm.)."

Brady's original description is given and his figures repro-

duced on our plate. The types of the species are from *Porcupine* sta. 20, northwest of Ireland. Specimens from *Porcupine* sta. 29 are figured here.

A study of d'Orbigny's model of *B. elegans* has shown that it belongs to the genus *Buliminella* (Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 93). It is necessary, therefore, to give specific rank to this form. It shows no close affiliation to any known species.

BULIMINA PYRULA d'Orbigny, var. SPINESCENS H. B. Brady (Pl. 2, figs. 22-25)

Bulimina pyrula D'ORBIGNY, var. *spinescens* H. B. BRADY, Rep. Voy.

Challenger, Zool., vol. 9, 1884, p. 400, pl. 50, figs. 11, 12.

Variety differing from the typical in having the lower part of the test covered with short, sharp spines, not extending above the lowest part of the last-formed chamber.

Brady describes this variety from *Challenger* sta. 191A, off the Ki Islands, in 480 fathoms. His figures are reproduced here. The specimens figured here are from *Albatross* sta. D5222, Lat. 13° 38' 30" N., Long. 121° 42' 45" E.

This form bears some resemblance to *B. barbata* Cushman but is much more involute. Both *B. pyrula* and this variety have a partially involute test which approaches, in character, the involute genus *Globobulimina*.

BULIMINA SUBORNATA H. B. Brady (Pl. 2, figs. 26-28)

Bulimina subornata H. B. BRADY, Rep. Voy. *Challenger*, Zool., vol. 9, 1884, p. 402, pl. 51, figs. 6 a, b.

"Test oblong-ovate; resembling that of *Bulimina pupoides* in general form and segmentation; the earlier chambers ornamented externally with raised longitudinal costae; the aboral extremity generally armed with a stout spine. Shell-wall conspicuously foraminated. Length, $\frac{1}{50}$ th inch (0.5 mm.)."

The types of the species are from the *Hyalonema*-ground, south of Japan, in 345 fathoms, and off Aru Island, in 800 fathoms. Brady's original description is given above and his figures are reproduced here.

Our figured specimens are from *Albatross* sta. D5214, Lat. 12° 25' 18" N., Long. 123° 37' 15" E., and D5119, Lat. 13° 45' 05" N., Long. 120° 30' 30" E., in the Philippine Islands area.

The species is very distinctive and bears no close resemblance to any other Recent species. The costae are very irregular and low, giving the wall of the lower half of the test a roughened

appearance. They do not obscure the sutures, so that the structure of the basal chambers can be easily seen.

BULIMINA ROSTRATA H. B. Brady (Pl. 2, figs. 29-31)

Bulimina rostrata H. B. BRADY, Rep. Voy. *Challenger*, Zool., vol. 9, 1884, p. 408, pl. 51, figs. 14, 15.

"Test elongate, fusiform, broadest near the middle, tapering unequally towards the two ends; oral end obtuse or rounded, aboral portion of the shell drawn out to a fine point and often obliquely bent. Segmentation almost or entirely concealed by the surface-ornament, which consists of stout, continuous, longitudinal costae, covering the test except a small area at the distal end. Aperture of the normal bulimine character. Length $\frac{1}{80}$ th inch (0.3 mm.) or more."

Brady's original description is given and his figures reproduced. The species is described as occurring off the Cape Verde Islands, in 1,070 fathoms; north of Tristan d'Acunha, 1,425 fathoms; between the Cape of Good Hope and Kerguelen Island, 1,570 fathoms; and off the Ki Islands, 580 fathoms.

The figured specimen is from *Lydonia* sta. 30 (22), Lat. 7° 01' N., Long. 81° 48.7' W., in 428 fathoms. The species most closely resembles *B. truncana* Gümbel but is more slender, tapers more gradually, and lacks the angled character which makes the latter almost triangular in cross section.

BULIMINA ORNATA Egger (Pl. 2, fig. 32)

Bulimina ornata ECGER, Abhandl. K. bay. Wiss. München, cl. II, vol. 18, 1893, p. 286, pl. 3, fig. 80.

Test cone-shaped with the initial end a rounded point, consisting of four to five whorls of three rounded chambers each, ending at the apertural end with an off-set, rounded, upward-projecting last chamber. Sutures not very depressed; the surface of the chambers covered with papillae of equal size, low, rising above the surface where the perforations pierce the wall, arranged to give the appearance of a closely striped pattern. Length, 0.15 mm.; width 0.09 mm.

The types of the species are from the *Gazelle* West Australian sta. 90, in 359 meters. This station is close to Australia. An outline of Egger's original description is given and the original figure reproduced on our plate.

We have no material referable to this species. It seems very

close to *B. fijiensis* Cushman but the latter, although it has very prominent, large perforations, shows no trace of papillae.

BULIMINA CONSOBRINA Fornasini (Pl. 2, fig. 33)

Bulimina consobrina FORNASINI, Mem. Accad. Sci. Istit. Bologna, vol. 8, 1900, p. 20, text fig. 23.

Fornasini describes this form as very elongate, pointed and graceful in the early portion, composed of numerous, inflated chambers, the early ones arranged in regular series, the later ones, which are fewer in number, less regular.

The types are from Porto Corsini, near Ravenna, Italy.

We have no specimens referable to this species. It shows considerable resemblance to the smoother specimens of *B. baccata* Fornasini, especially in the early portion of the test, but lack of material makes it impossible to definitely connect the two species. The original figure is reproduced here.

"BULIMINA FUSIFORMIS Williamson, var. BACCATA Fornasini"=

BULIMINA BACCATA Fornasini (Pl. 3, figs. 1-6)

Bulimina fusiformis WILLIAMSON, var. *baccata* FORNASINI, Mem. Accad. Sci. Istit. Bologna, ser. 5, vol. 9, 1901, p. 9, pl. 0, figs. 2, 5, 30.

Bulimina fusiformis FORNASINI (not WILLIAMSON), l. c., p. 10, pl. 0, figs. 1, 3, 4, 16, 18, 21, 23, 27, 36, 40 (not 6, 9, 41).

Bulimina elongata D'ORBIGNY, var. *ariminensis* FORNASINI (not D'ORBIGNY), l. c., p. 9, pl. 0, figs. 8, 11.

Bulimina elongata FORNASINI (not D'ORBIGNY), l. c., p. 8, pl. 0, figs. 12, 20, 37 (not 10).

Bulimina gibba FORNASINI, l. c., p. 10, pl. 0, figs. 32, 34.

Bulimina elegans H. B. BRADY (not D'ORBIGNY), Rep. Voy. Challenger, Zool., vol. 9, 1884, p. 398, pl. 50, figs. 1-4.

Test of medium size, gradually tapering, initial portion somewhat triangular in cross section, often with a terminal spine; chambers numerous, 5-6 whorls, distinct, very slightly inflated; sutures distinct, slightly depressed; wall smooth, polished, finely perforate, usually ornamented at the base with short spines; aperture loop-shaped, broad, with a slight lip. Length 0.33-0.58 mm.; diameter 0.20-0.23 mm.

Fornasini in his work on the genus *Bulimina* in the Adriatic Sea subdivided it to a great extent. Close study shows that some of these subdivisions may be combined under one species. While there is considerable variation within the species *B. baccata*, a study of the specimens in regard to the shape of the basal portion of the test, the shape of the chambers, aperture, etc., reveals

their close relationship. Specimens from Villefranche, France, are figured here and also a reproduction of Fornasini's first figure of "*Bulimina fusiformis*, var. *baccata*."

The species shows a marked resemblance to *B. etnea* Seguenza, but differs from it in the almost entire absence of marginal overhang of the chambers, this characteristic appearing only occasionally in the basal portion of the test. It seems possible that *B. baccata* and *B. marginata* show two diverging products of the evolution of Seguenza's species. The species differs from *B. elongata* in being more tapering, in having the triangular basal portion, and in the more spinose character of the test.

BULIMINA TORTA Cushman (Pl. 3, fig. 8)

Bulimina torta CUSHMAN, Bull. 71, U. S. Nat. Mus., pt. 2, 1911, p. 81, text figs. 133 a-c.

"Test elongate, broadest near the apertural end, tapering to the subacute apical end; apertural end broadly rounded; early portion slightly compressed; later portion circular in cross section; chambers several, somewhat inflated; sutures depressed; wall calcareous, perforate, smooth; aperture very long and narrow, curved, broadest at the upper end; color white. Length 0.65 mm."

The type is from *Albatross* sta. H. 2902, 1,783 fathoms, northeast of the Hawaiian Islands. The holotype is refigured here.

This species is rendered unique by the long, slit-like aperture which curves over the top of the test. It is questionable whether it actually belongs in this genus at all. The number of specimens, however, is so limited that the study of the internal structure must wait until more material is available. It is only known from the area northeast of the Hawaiian Islands.

BULIMINA SUBAFFINIS Cushman (Pl. 3, fig. 7)

Bulimina subaffinis CUSHMAN, Bull. 100, U. S. Nat. Mus., vol. 4, 1922, p. 166, text figs. 7 a, b.

"Test fusiform, apical end sharply pointed, apertural end with a rounded point, bases of the chambers gradually appearing somewhat above the apex, the last-formed one extending from the apertural end to about three-fourths of the way back on the test, surface smooth, aperture a comma-shaped slit with a tooth. Length about 1 mm. or slightly more."

The types are from *Albatross* sta. D5201, from Sogod Bay,

southern Leyte, in 554 fathoms. The holotype is refigured here.

The species is larger and more pointed at the base than *B. ovata* d'Orbigny, and is more ovate than *B. affinis* d'Orbigny, as well as having less inflated chambers.

"BULIMINA INFLATA Seguenza, var. MEXICANA Cushman"=

BULIMINA STRIATA d'Orbigny, var. MEXICANA Cushman (Pl. 3, fig. 9)

Bulimina inflata SEGUENZA, var. *mexicana* CUSHMAN, Bull. 104, U. S. Nat. Mus., pt. 3, 1922, p. 95, pl. 21, fig. 2.

"Test differing from the typical in the larger number, higher and more definite ridges tending toward *B. buchiana*. The form, however, is that of *inflata*. The test is more translucent, and thinner than in the northern form."

In a recent paper by the present authors (Contr. Cushman Lab. Foram. Res., vol. 14, 1938, p. 90) the species *B. striata* and *B. inflata* were compared and the conclusion reached that the two were probably synonymous. Further study shows, however, that there actually are two separate species. In *B. striata* the costae are usually cut off at the sutures giving a very definite collared effect to the test, whereas in *B. inflata* the costae often cross the sutures and the collared effect is much less marked. *B. striata* almost invariably has a terminal spine while *B. inflata* usually has not. Those characteristics which denote *B. striata* are marked in Cushman's variety and therefore the name should be changed to *Bulimina striata* d'Orbigny, var. *mexicana* Cushman. In this variety the costae are terminated by short spines at the sutures. It has a wide occurrence both in the Atlantic and Pacific Oceans and many of the Recent forms which have been called *B. inflata* belong here.

The types of the variety are from *Albatross* sta. 2377, in 210 fathoms, Lat. 29° 07' 30" N., 88° 08' W. The holotype is refigured here.

BULIMINA BARBATA Cushman (Pl. 3, fig. 10)

Bulimina barbata CUSHMAN, Bull. Scripps Instit. Oceanography, Tech. ser. vol. 1, No. 10, 1927, p. 151, pl. 2, fig. 11.

"Test broadly oval in side view, the greatest width at or below the middle; sutures distinct, slightly depressed; the last-formed chamber extending about halfway back on the test; early portion clothed with fine acicular spines, later portion entirely smooth. Length, 0.75 mm.; breadth, 0.40 mm."

The types of the species are from *Discoverer* sta. 9D, Lat. 36° 40' N., Long. 122° 26' W., 1,121 fathoms. The original figure is reproduced here.

The species resembles *B. pyrula* d'Orbigny, var. *spinescens* H. B. Brady, but differs from it in being less involute, having somewhat more inflated chambers, and longer spines.

BULIMINA PAGODA Cushman (Pl. 3, figs. 11, 12)

Bulimina pagoda CUSHMAN, Bull. Scripps Instit. Oceanography, Tech. ser., vol. 1, No. 10, 1927, p. 152, pl. 2, fig. 16.

"Test tapering, broadest near the apertural end, pointed at the initial end; chambers distinct, deeply cut under at the base; periphery of the chamber with a series of large stout spines projecting outward and curving downward, several on each chamber; wall thin and translucent, otherwise smooth. Length, 0.50 mm.; breadth, 0.40 mm."

The types are from *Lydonia* sta. 30, Lat. 7° 0.1' N., Long. 81° 48.7' W., in 428 fathoms. This station is south of Panama and is the only known locality for the species. The original figure is reproduced here and one of the paratypes is also figured.

The species differs from *B. striata* d'Orbigny and related species in the flaring of the chambers of the last whorl and in having the projecting spines.

BULIMINA PATAGONICA d'Orbigny, var. **GLABRA** Cushman and Wickenden
(Pl. 3, figs. 13, 14)

Bulimina patagonica D'ORBIGNY, var. *glabra* CUSHMAN and WICKENDEN, Proc. U. S. Nat. Mus., vol. 75, art. 9, 1929, p. 9, pl. 4, figs. 1 a-c.

"Test broadest near the apertural end and much like d'Orbigny's figure of *Bulimina patagonica*, except that the ornamentation at the base of the chambers is wanting."

The relationships between this form and *B. patagonica* d'Orbigny and *B. elongata* d'Orbigny are very close. It seems probable that the differences are only varietal. This variety differs from *B. elongata* in the inflation of the last whorl which is a consistent characteristic of the specimens from South America.

The types of the species are from Cumberland Bay, Juan Fernandez Island, Chile. The holotype is refigured and a topotype figured.

BULIMINA FIJIENSIS Cushman (Pl. 3, figs. 15, 16)

Bulimina fijiensis CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 9, 1933, p. 79, pl. 8, figs. 7 a-c.

"Test small, stout, slightly longer than broad, rounded; chambers distinct, inflated, comparatively few, increasing rapidly in size as added; sutures distinct, depressed; wall coarsely perforate except about the aperture where it is apparently without perforations; aperture elongate, somewhat comma-shaped, at the base of the apertural chamber and extending somewhat into the apertural face. Length, 0.25 mm.; breadth, 0.15 mm."

The types of the species are from Nairai, Fiji, in 12 fathoms. The original figures are reproduced here and a specimen from Zanzibar is also figured.

A discussion of the relationship of this form with *B. ornata* Egger has already been given under that species.

BULIMINA BREVITRIGONA Chapman and Parr (Pl. 3, fig. 18)

Bulimina brevitrigona CHAPMAN and PARR, Australasian Antarctic Exped., ser. C, vol. 1, pt. 2, 1937, p. 85, pl. 8, fig. 13.

"Test conical; short and broadly trigonal; consisting of a trifacial series of moderately inflated chambers, the last of which are comparatively large and well-inflated; sutures well impressed, aperture a curved slit between the sutures of the last three chambers, the edges of which are delicately toothed. Aboral end somewhat acute. Test hyaline, finely tubulate and polished on the surface.

"Length, 0.7 mm.; width, 0.67 mm.

"This species is practically isomorphous with *Verneuilina bradyi* Cushman, which has a finely arenaceous test."

The types of the species are from sta. XXII of the Mawson Australasian Antarctic Expedition, Lat. 66° 13' S., Long. 94° 15' E., in 125 fathoms. The original figure is reproduced here.

We have no material to illustrate this species. It seems questionable whether the form is a true *Bulimina*, as the aperture is apparently not typical. If the species is isomorphous with *Eggerella bradyi* (Cushman) as described, this is certainly true, as the aperture in the latter genus is not placed in the same position as in *Bulimina*, and is differently shaped. In addition, the arenaceous form has five chambers to the whorl in the early portion of the test. A study of the original specimens would have to be made before a final analysis of its generic characters could be made.

BULIMINA BUCHIANA d'Orbigny, var. **GUTTA** Chapman and Parr (Pl. 3, fig. 17)

Bulimina buchiana D'ORBIGNY, var. *gutta* CHAPMAN and PARR,
Australasian Antarctic Exped., ser. C, vol. 1, pt. 2, 1937, p. 86, pl. 8,
fig. 14.

"Test elongate, ovate, slightly curved, wider at oral end, pointed aborally; sides gently convex. Surface ornamented with about ten fine sharp costae persistent to the penultimate chamber; aperture bulimine, situated in a slight concavity.

"Dimensions: Length, 0.40 mm.; greatest width, 0.19 mm.

"This variety has a more slender habit of growth than the specific form. Its narrow and slightly curved test makes it easily distinguishable from typical examples of *Bulimina buchiana*. *Bulimina rostrata*, at first suggestive of the above variety, differs in the dominant costae, obliterating the suture lines, as well as in the aciculate aboral end."

The types are from sta. XLVII of the Mawson Australasian Antarctic Expedition, Lat. $42^{\circ} 38\frac{1}{2}'$ S., $148^{\circ} 41\frac{1}{2}'$ E., in 1,320 fathoms.

The original description of Chapman and Parr is given and their figure reproduced on our plate. We have no material referable to this species.

Subgenus DESINOBULIMINA, n. subgen.

Subgenoholotype, *Bulimina auriculata* Bailey

Test with the early chambers like *Bulimina* but with the aperture of the last-formed chambers becoming terminal, connected with the earlier apertures by an internal trough, which is joined to one side of the aperture toward the front, and projects above it at the back in the form of a tooth.

Many of the smooth species of *Bulimina* show a tendency to develop in this direction. All forms which have an apertural tooth have at least an incipient trough-like connection between the apertures. As a general rule, however, the apertures themselves are also connected, the lower part of the aperture of the last chamber joining the upper end of the aperture of the previous chamber, etc. Only relatively few species show the aperture becoming terminal with the trough as the sole means of communication. In these forms the trough extends down from the final aperture and twists around to join the tooth-like protuberance of the previous one. It is for species of this type that the subgeneric name *Desinobulimina* is proposed.

The earliest known form showing these characteristics is *B. quadrata* Plummer, from the Midway Eocene of Texas. Mrs. Plummer used the generic name *Ellipsobulimina* Silvestri, 1903, as a subgeneric name for this form. A study of Silvestri's description and figure, however, shows this to be a completely involute form, with the chambers arranged biserially throughout most of the test, finally becoming uniserial.

"BULIMINA AURICULATA Bailey"=

BULIMINA (DESINOBU LIMINA) AURICULATA Bailey (Pl. 3, figs. 19-21)

Bulimina auriculata BAILEY, Smithsonian Contrib., vol. 2, art. 3, 1851, p. 12, pl., figs. 25-27.

"Shell ellipsoidal, smooth or very minutely punctate, sutures not very distinct. Aperture with an ear-shaped appendage."

Bailey's original description is given above. The types of the species are from southeast of Montauk Point, Long Island, Lat. 40° 21' 54" N., Long. 70° 55' 35" W., in 51 fathoms. Our figures are from south of Block Island, in 112 meters.

Although Bailey's figures are poor, a study of specimens from this same general region shows that they should be referred to this species. The broad, curved tooth in the aperture is very typical and is well described as an "ear-shaped appendage." The species is, perhaps, most closely related to *B. ovata* d'Orbigny, but is larger, has less inflated chambers, and has the characteristic terminal aperture with the trough-like connection with the earlier apertures. It is interesting to note that the young forms of the species take the form of a true *Bulimina* so that only the adult forms show the subgeneric characteristics.

"BULIMINA TURGIDA Bailey"=

BULIMINA (DESINOBU LIMINA) TURGIDA Bailey (Pl. 3, figs. 22-24)

Bulimina turgida BAILEY, Smithsonian Contrib., vol. 2, art. 3, 1851, p. 12, pl., figs. 28-31.

Bulimina dolioleum TERQUEM, Bull. Soc. Zool. France, vol. 11, 1886, p. 333, pl. 11, figs. 17, 18.

Bulimina ovooides TERQUEM, l. c., p. 334, pl. 11, fig. 20.

"Shell ovoidal, smooth, and having several small dentate projections at the apex; cells much inflated, separated by deep sutures, apertures nearly symmetrical, with a raised border."

The types of the species are from sta. E. No. 9, Lat. 40° 21' 54" N., Long. 70° 55' 35" W., southeast of Montauk Point, Long Island, in 51 fathoms; and F. No. 24, Lat. 39° 52' 40" N., Long.

72° 14' W., southeast of Fire Island Inlet, in 49 fathoms. The specimens figured here are from south of Block Island, in 112 meters. One immature specimen from Dröbach, Norway, is also figured to show its resemblance to Terquem's species.

The specimens found on the west side of the Atlantic Ocean are identical with the eastern Atlantic forms. Terquem's species have been placed in the synonymy here owing to the marked resemblance between his figured specimens and immature specimens of *B. turgida*, both having the same involute character and basal spine.

The swollen, inflated chambers and the heavy short spines at the base of the test differentiate the species from any other. In addition the adult specimens have the terminal aperture and connecting trough of the *Desinobulimina* group.

Questionable species:

Bulimina auricula Heron-Allen and Earland (*Discovery Reports*, vol. 4, 1932, p. 351, pl. 9, figs. 1, 2) = *Buliminella*??

Bulimina chapmani Heron-Allen and Earland (*British Antarctic Exped., Zool.*, vol. 6, No. 2, 1922, p. 130, pl. 4, figs. 18-20) = *Ceratobulimina chapmani* (Heron-Allen and Earland).

Bulimina compressa Bailey (*Smithsonian Contr.*, vol. 2, art. 3, 1851, p. 12, pl., figs. 35-37) = *Virgulina compressa* (Bailey) (Cushman, *Bull.* 104, U. S. Nat. Mus., pt. 3, 1922, p. 116, pl. 24, figs. 2, 3).

Bulimina convoluta Williamson, var. *nitida* Millett (*Journ. Roy. Micr. Soc.*, 1900, p. 280, pl. 2, fig. 10) = *Cushmanella*??

Bulimina cuneiformis Terquem (*Essai. Class. Anim. Dunkerque*, fasc. 3, 1881, p. 127, pl. 16, figs. 11 *a*, *b*) = arenaceous form?

Bulimina elegantissima d'Orbigny (*Voy. Amér. Mérid.*, vol. 5, "Foraminifères," 1839, p. 51, pl. 7, figs. 13, 14) = *Buliminella elegantissima* (d'Orbigny).

Bulimina elegantissima d'Orbigny, var. *compressa* Millett (*Journ. Roy. Micr. Soc.*, 1900, p. 277, pl. 2, fig. 5) = *Buliminella* (This form is a homonym of *Bulimina compressa* Bailey).

Bulimina elegantissima d'Orbigny, var. *fusiformis* Sidebottom (*Journ. Roy. Micr. Soc.*, 1918, p. 234, pl. 3, figs. 8-10) = *Buliminella*.

Bulimina marginata d'Orbigny, var. *biserialis* Millett (*Journ. Roy. Micr. Soc.*, 1900, p. 278, pl. 2, fig. 7) = *Suggrunda*?

Bulimina normani Goës (*Köngl. Svensk. Vet.-Akad. Handl.*, Bd. 25, No. 9, 1894, p. 47, pl. 9, figs. 437, 438) = *Robertina*.

- Bulimina ovulum* Harting (Verh. Kon. Akad. Wetensch., vol. 10, 1864, p. 9, pl. 1, figs. 10 a, b) ?? (figure unrecognizable).
- Bulimina parkeri* Terquem (Bull. Soc. Zool. France, vol. 11, 1886, p. 334, pl. 11, fig. 19) = *Robertina parkeri* (Terquem), a synonym of *Robertina arctica* d'Orbigny (Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 93, pl. 16, figs. 1 a, b).
- Bulimina pupoides* d'Orbigny, var. *convoluta* Williamson (Rec. British Foram., 1858, p. 63, pl. 5, figs. 132, 133) = ? (not *Robertina convoluta* (Williamson) (Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 94, pl. 16, figs. 4 a, b)).
- Bulimina pupoides* d'Orbigny, var. *fusiformis* Williamson (Rec. British Foram., 1858, p. 63, pl. 5, figs. 129, 130) = *Virgulina fusiformis* (Williamson) (Cushman, Bull. 4, Florida State Geol. Survey, 1930, p. 45, pl. 8, figs. 8 a, b).
- Bulimina pyrala* d'Orbigny, var. *perversa* Cushman (Bull. 100, U. S. Nat. Mus., vol. 4, 1921, p. 163, figs. 2 a-c) = *Globobulimina*.
- Bulimina scabra* Williamson (Rec. British Foram., 1858, p. 65, pl. 5, figs. 136, 137 [*B. arenacea* on expl. of plate]) = *Eggerella scabra* (Williamson) (Cushman, Cushman Lab. Foram. Res., Spec. Publ. No. 8, 1937, p. 50, pl. 5, figs. 10, 11).
- Bulimina spinifera* Cushman (Bull. Scripps Instit. Oceanography, Tech. ser., vol. 1, No. 10, 1927, p. 151, pl. 2, fig. 15) = *Globobulimina*.

EXPLANATION OF PLATE 3

FIGS. 1-6. *Bulimina baccata* Fornasini. 1, $\times 45$, (after Fornasini), Porto Corsini, near Ravenna, Italy. 2-6, $\times 52$, off Villefranche, France.

7. *B. subaffinis* Cushman. $\times 24$, Albatross sta. D5201. Holotype. 8. *B. torta* Cushman. $\times 52$, Albatross sta. H2902. Holotype. 9. *B. striata* d'Orbigny, var. *mexicana* Cushman. $\times 38$, Albatross sta. D2377. Holotype.

10. *B. barbata* Cushman. $\times 38$, Discoverer sta. 9D. Holotype. 11, 12. *B. pagoda* Cushman. Lydonia sta. 30. 11, $\times 38$. Holotype. 12, $\times 67$. Paratype. 13, 14. *B. patagonica* d'Orbigny, var. *glabra* Cushman and Wicken-den. $\times 67$, Cumberland Bay, Juan Fernandez Island, Chile. 13. Holotype. 14. Topotype. 15, 16. *B. fijiensis* Cushman. 15, $\times 60$, Nairai, Fiji. Holotype. 16, $\times 97$, Zanzibar. 17. *B. buchiana* d'Orbigny, var. *gutta* Chapman and Parr. $\times 75$. (After Chapman and Parr), sta. XLVII, Mawson Australasian Antarctic Expedition. 18. *B. brevitrigona* Chapman and Parr. $\times 75$. (After Chapman and Parr), sta. XXII, Mawson Australasian Antarctic Expedition. 19-21. *B. (Desinobulimina) auriculata* Bailey. South of Block Island. 19, 20, $\times 38$, a, a, front views; b, b, side views. 21, $\times 52$, front view with part of wall removed to show internal structure.

22-24. *B. turrida* Bailey. $\times 38$. 22, 23, south of Block Island. 24, Dröbach, Norway.

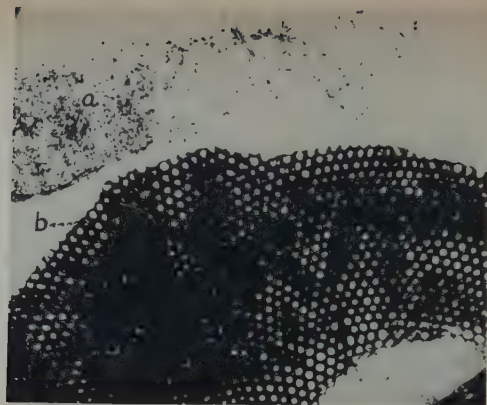




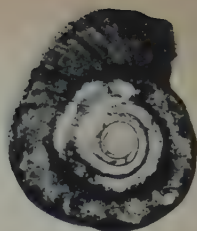
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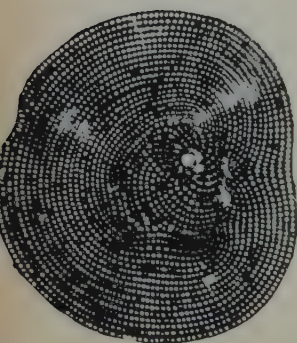
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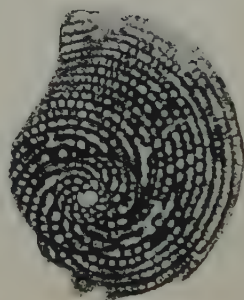
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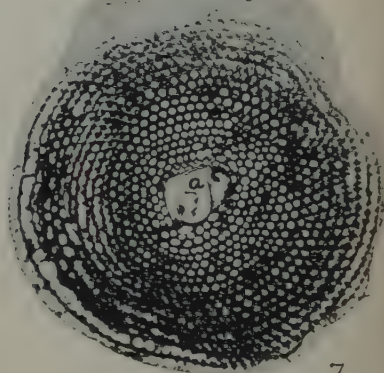
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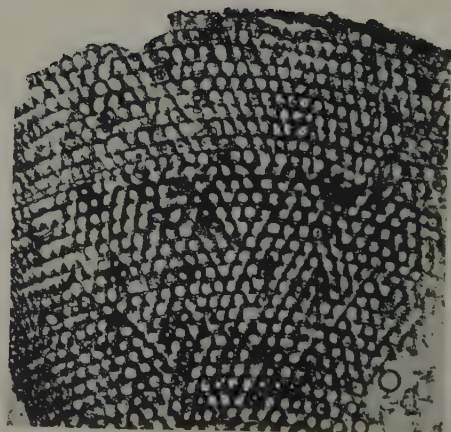
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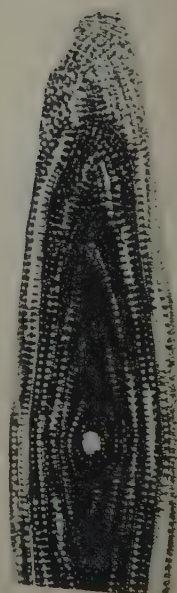
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12

- Bulimina subcylindrica* H. B. Brady (Quart. Journ. Micr. Sci., vol. 21, 1881, p. 56; Rep. Voy. *Challenger*, Zool., vol. 9, 1884, p. 404, pl. 50, figs. 16 *a*, *b*)=*Robertina subcylindrica* (H. B. Brady) (Cushman and Parker, Contr. Cushman Lab. Foram. Res., vol. 12, 1936, p. 95, pl. 16, figs. 10 *a*, *b*).
- Bulimina subteres* H. B. Brady (Quart. Journ. Micr. Sci., vol. 21, 1881, p. 25)=*Robertina*.
- Bulimina williamsoniana* H. B. Brady (Quart. Journ. Micr. Sci., vol. 21, 1881, p. 56; Rep. Voy. *Challenger*, Zool., vol. 9, 1884, p. 408, pl. 51, figs. 16, 17)=*Buliminoides williamsoniana* (H. B. Brady) (Cushman, Smithsonian Misc. Coll., vol. 77, No. 4, 1925, p. 36, pl. 7, fig. 2).
-

EXPLANATION OF PLATE 4

FIGS. 1, 2. *Cornuspira involvens* (Reuss). Partial sections showing shell wall made up of crypto-crystalline calcite with chitin uniformly distributed throughout the calcite. Dark matter contained within last whorl of fig. 2, is foreign matter containing diatoms and minute foraminifera. 3 *a-b*. *Marginopora vertebralis* Blainville. Specimen treated with weak acid showing (*a*), peripheral residue of chitin, (*b*), main mass of the undissolved shell wall. 4. *Massilina* sp. Crypto-crystalline calcite shell wall containing a uniform mixture of chitin. 5. *Sorites marginalis* (Lamarck). Crypto-crystalline calcite shell wall containing a uniform mixture of chitin. 6. *Marginopora vertebralis* Blainville. Finely fibrous calcite shell wall containing a mixture of chitin. 7. *Marginopora vertebralis* Blainville. Finely fibrous calcite wall containing a mixture of chitin. Light central portion (*a*), made up of slightly birefringent chitin, granular in appearance. 8. *Archaias aduncus* (Fichtel and Moll). Crypto-crystalline calcite wall containing chitin in direct association with the calcite. 9. *Peneroplis pertusus* (Forskål). Crypto-crystalline calcite wall containing chitin mixed with the calcite. 10. *Massilina arenaria* (H. B. Brady). Crypto-crystalline calcite wall containing much foreign material scattered throughout the wall. Calcium carbonate cement. Optically birefringent chitinous lining visible in section. (*a*, *a'*). 11. *Marginopora vertebralis* Blainville. A very thin section of the crypto-crystalline calcite wall containing a mixture of chitin.

216. A PRELIMINARY STUDY OF THE STRUCTURE
 OF THE TEST IN THE SO-CALLED
 PORCELLANOUS FORAMINIFERA

By J. A. CUSHMAN and W. C. WARNER

The so-called porcellanous or imperforate foraminifera have a very definite appearance, a chalky white color, and for the most part are characteristic of shoal water in tropical and subtropical regions. They include several families some of which first appeared in the Paleozoic. Various statements have been made in the literature as to the characters and material of the test. In order to attempt a study of the wall structure and the materials of which it is composed it was thought best to use only Recent specimens in order to avoid any complications due to possible replacement. Sections were made and later studied in the Petrographic Laboratory of Harvard University. We wish to extend our thanks to Prof. Esper S. Larsen for use of the laboratory facilities and to Mr. George E. Moore for his interest and help in the study of the sections.

It became evident at once that the material of the test was of especial interest. The sections were studied petrographically. Another means of attack on the problem was the treatment of entire specimens with very weak hydrochloric acid, weak enough to avoid strong effervescence and consequent disrupting of the wall. It was found in *Cornuspira* that the entire test could be decalcified in this way and the resulting chitinous test kept the shape of the original specimen. In other more complex forms such as *Marginopora* (Pl. 4, fig. 3) by very slow decalcification the calcareous material was entirely dissolved away leaving a purely chitinous test retaining the original shape and structure. This resulting chitinous test is very soft and easily disrupted so that mounting it to show the chambers is an almost impossible task.

The following notes give in brief form the results of the petrographic study of the various forms:

Cornuspira. (Pl. 4, figs. 1, 2.) Crypto-crystalline calcite and chitin mixed throughout the wall. The darkened material at the junction of the whorls is the thickened, more birefringent mate-

rial existing at these points. The darkened material contained within the last whorl is foreign material, containing diatoms and very fine foraminifera. The insoluble residue of chitin obtained after treatment with acid agrees optically with tests of pure chitin obtained from other sources.

Sigmoilina. (Pl. 4, fig. 4.) The test consists of a micro-crystalline calcite wall uniformly mixed with chitin.

Massilina. (Pl. 4, fig. 10.) The test consists of crypto-crystalline calcite containing much heterogeneous foreign mineral matter scattered throughout the wall. The cement is calcium carbonate. Chitin in direct association with calcium carbonate is found as a lining in the chambers, readily visible in section (*a*, *a'*) and is optically birefringent.

Peneroplis. (Pl. 4, fig. 9.) The wall of the test is crypto-crystalline calcite containing chitin in direct association with the calcite.

Sorites. (Pl. 4, fig. 5.) The wall is of micro-crystalline calcite containing a uniform mixture of chitin.

Archaias. (Pl. 4, fig. 8.) The wall is of crypto-crystalline calcite mixed with the chitin. The calcite of the walls is more evident petrographically than that of the other genera examined.

Marginopora. (Pl. 4, figs. 3, 6, 7, 11.) The wall consists of very finely fibrous calcite containing chitin in direct association with the calcite. These two elements seem to be actually mixed together. The chitin is obtained as an insoluble residue when the test is treated with very dilute acid. The central portion of one section of this genus (Pl. 4, fig. 7, *a*) contains chitin which is slightly optically birefringent due to its admixture with calcite. The central chitinous zone also appears to be either finely granular or finely porous although no pores were seen with high magnifications, but appear rather as depressions of the surface.

Alveolinella. (Pl. 4, fig. 12.) The wall is of crypto-crystalline calcite with chitin distributed throughout the calcite. By decalcification the chitin was obtained as an insoluble residue and was amorphous.

The conclusion seems to be that the Miliolidae, Ophthalmitidae, Peneroplidae, Alveolinellidae and probably the Keramosphaeridae have a test composed of an admixture of chitin and crypto-crystalline calcite. In Pl. 4, fig. 10, is a section of a specimen of *Massilina* which has an interior lining of birefringent chitin similar to that of *Marginopora* (Pl. 4, fig. 7) the main outer wall

of which is composed of heterogenous foreign particles.

Photographs of some of the sections are given on our plate.

217. ASTERIGERINA TOMBIGBEENSIS CUSHMAN
 AND GARRETT, A NEW NAME

By J. A. CUSHMAN and J. B. GARRETT

Through an oversight the name *Asterigerina alabamensis* was given by us to a species from the Eocene of Woods Bluff, Alabama, in these "Contributions" (vol. 15, pt. 4, Dec., 1939, p. 86, pl. 15, fig. 11) when it had already been used for a species from the Oligocene of Choctaw Bluff, Alabama, by Cushman and McGlamery (U. S. Geol. Survey Prof. Paper 189, 1938, p. 111, pl. 28, fig. 5). A new name must be given to the Eocene species from Woods Bluff, Alabama, and it is therefore here named *Asterigerina tombigbeensis* Cushman and Garrett.

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